## Examples of data quality issues with the NSA C1 AERI system

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The AERI at the NSA C1 site has become increasingly noisy since late 2004. We have looked at the hot blackbody (HBB) data collected by the instrument in an attempt to understand the characteristics of this noise. Some examples of the HBB data are provided in Figure 1.

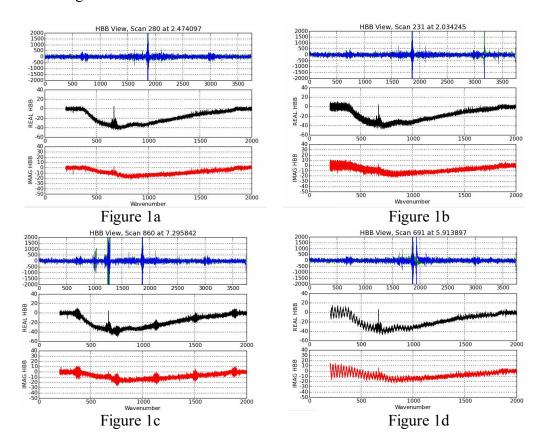


Fig 1a demonstrates what a "normal" HBB view looks like, both as a real-valued double-sided interferogram (top) and the real (middle) and imaginary (bottom) part of the complex spectra. The x-axis of the interferogram denotes data array measurements along the sampling path. The zero path difference (ZPD) is around point x=1820.

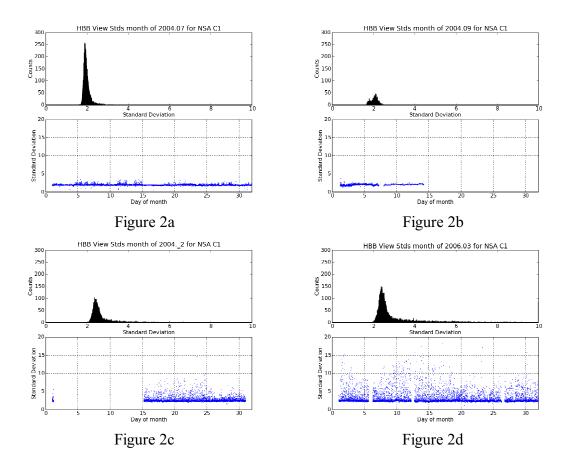
Fig 1b provides an example of one type of noise that is seen quite frequently in the data. A spike in the interferogram around x=3200 translates into increased noise in both the real and imaginary parts of the complex spectrum; examine the "width" of the spectrum at 400 cm<sup>-1</sup> in Fig 1b relative to the width of the normal spectrum in Fig 1a. This additional width translates into more uncertainty (i.e., noise) across the entire spectrum. It should be noted that the spike appears in different locations of the interferogram.

Fig 1c illustrates another common feature seen in the data. Again, a strong spike at x=1300 is seen in the inteferogram (note that the character of the spike, namely the width,

is different than the spike seen in Fig 1b), with a secondary spike at x=1010. These spikes translate into periodic "pulsing" in the real and imaginary components of the spectrum.

Fig 1d illustrates a fourth problem that is seen in the data. Again, it manifests itself as a spike in the interferogram, but in this case it translates into a sinusoidal wave in the spectrum. This particular feature has not been observed very frequently.

As indicated above, these examples were drawn from the HBB views, which are easier to understand then sky views, which are complicated by the changing nature of the scene (i.e., clear sky / cloudy, low / high water vapor, etc.). From these data, it appears that the AERI data is being affected in a manner that results in spikes being inserted into the interferogram, and the impact on the spectra depends on the nature of the spike. One possible source of these spikes could be outside RF interference. It appears that the data is only affected occasionally; in other words, it does not look like there is a constant noise source that is affecting the interferograms but rather some periodic interference that is affecting the instrument. At this time, we do not know what the exact period of this interference might be, or if it is a random event. However, as we will show below, a significant number of the HBB views, as well as the ambient BB and sky views, are affected. Therefore, it is likely that over 50% of the data collected by this AERI system might be affected, especially since a "bad" BB view will adversely affect the calibration of all of the nearby sky views.



In order to quantify how frequently the HBB data are affected by increased noisiness, we've computed the standard deviation of the real component of the HBB spectrum across the wavenumber range from 400-500 cm<sup>-1</sup> for each HBB spectrum; these values are plotted in Fig 2 for the months July 2004 (a), early September 2004 before the system was modified to rapid-sample (b), late September 2004 after the system was put in rapidsample mode (c), and March 2006 (d). The rapid-sample data show that samples with high standard deviation, which correspond primarily with the cases shown in Fig 1b, occur quite frequently. However, in rapid-sample mode, each HBB spectrum is a 12second integration, while in normal-sample mode each HBB spectrum was a 2-min integration. Therefore, if the noise spike is occurring relatively infrequently during the inteferogram collection, then the longer averaging period will reduce the impact of the spike. Therefore, from these examples, it is not possible to conclude that the underlying problem that is inserting spikes into the interferogram is associated with the rapidsampling; most likely the decrease in the averaging allows the artifact to be seen more clearly. However, it is clear that a significant fraction of the HBB data is affected, which in turn affects the calibration of the nearby sky view data.